UNITED STATES DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN

WASHINGTON, D. C. 669 Rev. 8/22 ISSUED MAY, 1915 REVISED AUGUST, 1922

FIBER FLAX.

By FRANK C. MILES,

Scientific Assistant, Fiber-Plant Investigations, Bureau of Plant Industry.

CONTENTS.

INTRODUCTION.

The purpose of this bulletin is to discuss the production of flax for fiber, yet it must not be understood that the seed is lost in growing fiber flax. In the course of the work conducted by the Office of Fiber Investigations it has been found that many persons believed it impossible to produce a high grade of flax fiber without sacrificing the seed. This belief, however, has repeatedly been shown to be a misconception. It is true that the variety of flax commonly grown in the Northwest for seed production will not, under present methods, yield a fiber suitable for spinning purposes. It is also true that the yield of seed from fiber flax usually is lower than that from flax grown primarily for seed, yet the quantity of seed produced is sufficient to constitute a valuable by-product.

NOTE.—This bulletin is intended for distribution throughout those Northern and Pacific Coast States where the conditions of climate are favorable for the growth of fiber flax.

111971°—22——1

In all countries except Ireland where fiber flax is grown commercially the general practice is to save the seed. In Belgium, where the highest quality of fiber is produced, seed from the best types of flax is used for sowing and the remainder saved for feeding. In Russia the seed obtained is used for sowing, and in addition great quantities are exported for seed purposes. In Holland the seed is not only saved, but is highly prized for sowing. The characteristic climatic conditions in Ireland are such that the seed does not mature uniformly, and growers believe that the value of the seed which does mature is not sufficient to pay the cost of thrashing.

WORLD'S PRODUCTION OF FIBER FLAX.

According to the latest available statistics, about 1,300,000 acres are devoted to fiber flax each year, as compared with more than 4,000,000 acres previous to 1914. The present production is about 190,000 tons of fiber, as compared with about 800,000 tons in pre-war years. Russia, which before the war produced about 80 per cent of the world's supply of flax, now produces less than half the quantity needed for its own normal home consumption. The leading flax-fiber producing countries during the years 1918 to 1921 were the following: Belgium, France, Ireland, Netherlands, Czechoslovakia, and Japan. In the United States during these same years from 1,000 to 6,000 acres have been devoted to fiber flax, while about 1,700,000 are devoted to seed flax.

DISTRIBUTION OF FLAX SPINDLES.

Data obtained by the International Federation of Flax and Tow Spinners' Association in regard to the location of the flax spindles of the world in 1914 are shown in Table I.

TABLE I.—*Location of the flax-spinning factories of the world in 1914.*

Countries.	Number of spindles.	Countries.	Number of spindles.
United Kingdom	1,161,874	Italy	20,000
France	567,079	Sweden	18,158
Russia	367,207	United States	8,612
Belgium	315,404		
Austria-Hungary	296,833	Total	3,034,101
Germany	278,934		

Nearly one million spindles, or about one-third of the total number, are in Ireland. Irish linens are well known throughout this country, yet it is not generally known here that Ireland imports about three-fourths of the flax fiber used in the manufacture of these linens. Though France ranks second in number of spindles,

the manufacturers there find it necessary to import about four-fifths of the fiber which is used. The industry has not become stabilized since the war, but since 1914 there has been a marked increase in the number of spindles in Japan, and since 1919 a marked decrease in those in operation in the United Kingdom.

IMPORTATIONS OF FLAX FIBER AND LINENS.

The spinning mills of the United States have been importing flax fiber for many years, and importations of materials manufactured from flax have been steadily increasing. The people of the United States are great users of linen, as evidenced by the fact that the value of the goods imported each year is more than $20,000,000. The quantities of fiber and of linens imported annually are shown in Tables II and III.

TABLE II.—*Average annual imports into the United States of flax fiber in 5-year periods from 1881 to 1915 and annual imports for the years 1916 to 1921, inclusive.*

Years.	Quantity.	Value.	Import price per ton.[1]	Years.	Quantity.	Value.	Import price per ton.[1]
	Tons.				*Tons.*		
1881-1885	5,655	$1,542,069	$272.69	1916	6,939	$3,508,295	$505.59
1886-1890	6,866	1,911,888	278.46	1917	7,918	4,236,232	535.01
1891-1895	6,485	1,779,246	274.36	1918	5,607	5,818,473	1,037.71
1896-1900	7,198	1,569,759	218.08	1919	4,420	3,996,590	904.20
1901-1905	8,203	2,161,188	263.46	1920	6,791	3,848,949	566.78
1906-1910	9,909	2,634,882	265.91	1921	3,932	2,229,097	566.91
1911-1915	9,123	3,028,607	331.97				

[1] The import price of the fiber per ton is the average of all grades, including dressed line, scutched flax, tow of flax, etc. These were the declared values at the point of export and not the prices at which the fiber could be purchased in the United States.

More than half the linens exported from Ireland are sent to the United States, and the statistics show that fully three-fourths of our linen imports are received from that country.

TABLE III.—*Annual imports into the United States of linen goods for the fiscal years from 1904 to 1913, inclusive, and the calendar years from 1919 to 1921, inclusive.*

Year.	Value.	Year.	Value.
1904	$18,012,042	1911	$24,632,505
1905	17,930,367	1912	26,381,970
1906	21,382,886	1913	28,208,884
1907	23,783,323	1919	19,603,315
1908	19,693,823	1920	51,983,488
1909	20,245,595	1921	29,313,701
1910	27,423,896		

[1] The figures in this table, compiled from statistics published by the Department of Commerce, include woven linens, linen handkerchiefs, linen embroideries and laces, but not linen yarns, which will more than offset the value of cotton in some of the goods made partly of cotton yarns.

CONDITIONS IN THE UNITED STATES FAVORABLE FOR FIBER-FLAX PRODUCTION.

During the past years a number of statements have been made to the effect that flax fiber of good quality could not be produced in this country. Doubtless some of these statements were occasioned by failures of attempts to obtain fiber suitable for spinning purposes from the thrashed straw of the flax commonly grown in the Northwest for seed or oil production. In this connection it should be understood that flax grown for fiber is a variety distinct from that grown primarily for seed production. (See fig. 1.) Furthermore, it has been established that in order to produce fiber flax of good quality greater care is essential in the selection and especially in the preparation of the soil and in the selection and grading of seed than is commonly practiced in growing flax for oil.

FIG. 1.—A fiber-flax plant (on the left), showing the characteristic tall stalk and few seed bolls and a plant of seed flax (on the right), with shorter stalks and many seed bolls.

A few years ago fiber flax of excellent quality was grown in the Puget Sound region. At the request of a representative from one of the Irish mills a quantity of this flax straw was sent to Ireland for retting and preparing according to their methods. The report of the firm conducting the work stated that the fiber obtained in the test compared very favorably with that produced in the famous flax region of Courtrai, Belgium.

Fiber flax of good quality has repeatedly been grown in Minnesota, Wisconsin, and Michigan on a scale sufficient to demonstrate that it can be successfully done. In eastern Michigan and in Oregon it is now being grown commercially to a limited extent.

These various demonstrations indicate rather clearly that the soil and climatic conditions in certain sections of the United States are favorable for growing fiber flax provided the proper cultural methods are employed. The areas in which climatic conditions

are most favorable for growing fiber flax are shown on the accompanying map (fig. 2).

CLIMATIC RELATIONS.

Fiber flax can best be grown in regions where moderately cool, damp weather prevails during the summer. Under favorable soil conditions the plants respond to a humid atmosphere and a relatively low and uniform temperature during a long growing season by developing tall stalks with fiber of good quality. In localities where, during the season of growth, the temperature frequently rises to high points and the soil becomes very dry, the crop matures earlier and the plants are much shorter.

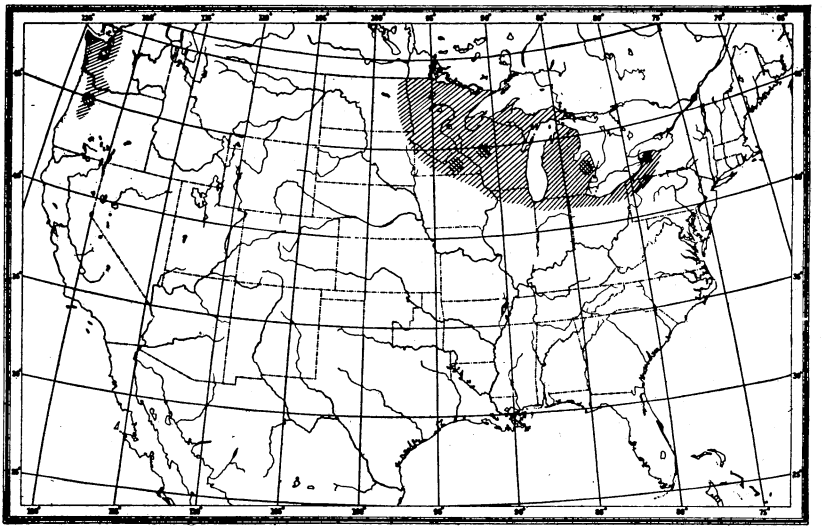

FIG. 2.—Map of the United States, showing by crossed lines the areas where fiber flax has been grown in recent years and by single lines areas having climatic conditions favorable for its production.

Sufficient moisture is needed to enable the plants to continue, without interruption, their growth during the period of elongation of the stems. Under certain conditions the soils of some regions might be capable of retaining moisture sufficient to meet the requirements of the plants throughout this period, but in nearly all cases rainfall is needed during this time. It is desirable that there should be little or no rainfall during the ripening period and harvesting time.

The weather records show that conditions of temperature and humidity of the principal flax-growing centers of Europe are very nearly the same as those which prevail in certain sections of New York, Michigan, Wisconsin, Minnesota, Oregon, and Washington. There are other localities in the United States where the climate is

suitable for growing flax for fiber, but the States mentioned are cited because fiber flax of good quality has been grown there.

SOIL RELATIONS.

The soils on which fiber flax is to be planted should be of such a nature that good drainage is afforded, as the plants will not endure severe inundation. At the same time the soil should have good water-retaining capacity. A gently sloping field having a loam soil with a clay subsoil is suitable, provided it is in a good state of fertility and is free from weeds.

Fiber flax has been grown on muck soils, and also on light sandy soils, with varying success. When grown upon muck the experience generally has been that the plants attained a good height, but the quality of the fiber was not equal to that of fiber produced on upland. When grown upon sandy soils the difficulty is that the crop is too dependent upon frequent rainfall for the necessary moisture, since there is so little available water stored in such a soil.

The land selected for fiber flax should be of good fertility. In Ireland the Department of Agriculture and Technical Instruction has found that the addition of some available form of potash to the soil has given profitable results in a series of experiments extending through several years, and it is recommending this practice to the Irish growers. It would be difficult to recommend a practice of fertilization which would be applicable to all sections where fiber flax can be grown, as the solution of this problem is governed very largely by local conditions. Many flax growers apply barnyard manure to the soil at some period of the rotation. If this practice is followed it is advisable that the manure be applied to a crop preceding flax, because if applied directly the flax is likely to be uneven, and quantities of weed seeds are nearly always introduced with stable or barnyard manure. Moreover, it is not advisable to use barnyard manure when flax straw has been used as bedding for the animals, since in this way the soil may become infected with flax diseases which live over in the old straw. If manure having flax straw or chaff in it is to be utilized for fertilizing land intended for flax, it should be thoroughly composted before being applied.

It has often been asserted that flax depletes the soil fertility to a greater extent than the other agricultural crops, and no doubt many of these assertions were based upon observation. If a farmer noted a diminished yield in the crop immediately following flax, he might conclude that the flax had required an extraordinary quantity of plant food. This conclusion, however, was based on apparent results, since the real cause of the diminished yields may not have been understood.

It has been found upon investigation that an average crop or flax removes less plant food from the soil than does a crop of corn or oats. Flax plants have delicate root systems which occupy only the upper few inches of the soil, while the plants of oats and corn have more vigorous root systems which may penetrate the subsoil. Hence oats and corn may obtain from the subsoil a portion of the food materials essential for plant development, but flax plants necessarily must obtain practically their entire nourishment from the upper few inches of surface soil which the roots occupy. Undoubtedly, then, more of the available plant food in the upper 5 or 6 inches of soil is removed by flax than by the deeper rooted crops. Therefore, in preparing flax stubble for the succeeding crop care should be taken to plow deep enough to bring up some of the subsoil in order to replenish the surface soil with available plant food.

PREPARATION OF THE SEED BED.

Too much emphasis can not be placed upon the necessity of a thorough preparation of the seed bed, for upon this more than upon any other cultural factor will depend the success or failure of fiber-flax production. It is indeed futile to attempt to produce a fine quality of fiber unless one is willing to expend the utmost effort in preparing the soil for seeding. Additional time and effort spent in putting the land in the best possible condition will be repaid (1) by a more uniform growth of plants, resulting in a more uniform quality of fiber, and (2) by greater ease in harvesting.

If a clover field or other sod is to be prepared for fiber flax, the field should be plowed in the fall. If flax follows a cultivated crop, spring plowing usually is satisfactory. Numerous dead furrows are to be avoided, as the flax which grows therein is short and difficult to harvest. A few days prior to seeding, the land should be double disked or cultivated with a spring-tooth harrow. In either case it is preferable to work the field diagonally. The peg-tooth harrow should be used as many times as may be necessary to render the soil very fine and to leave the surface smooth. A firm seed bed is very desirable, and in order to secure this it is often advisable to use a roller. The land is not ready for seeding until it has been reduced to a fine and compact condition.

SEED AND SEEDING.

Mention of the distinction between flax grown for fiber and that grown for seed or oil has already been made. The seed used in the United States for growing fiber flax is imported from the flax regions of Europe. Part of it is secured directly from Russia, though some growers prefer Russian seed which has been grown one or two years

in Holland or Belgium. Heretofore the practice has been to grow the stock of seed thus obtained for not more than three or four generations and then to import a fresh stock.

The results thus far obtained in experiments conducted by the Office of Fiber-Plant Investigations seem to indicate that these frequent importations of seed are unnecessary provided proper attention is given to a seed plat. It is recommended that a portion of the field be set apart for producing seed. All weeds should be pulled from this plat, and the crop should not be harvested until the seed is fully matured. The grower can afford to sacrifice the quality of the fiber from the seed plat in order to secure plump, well-matured seed for his general crop the next season.

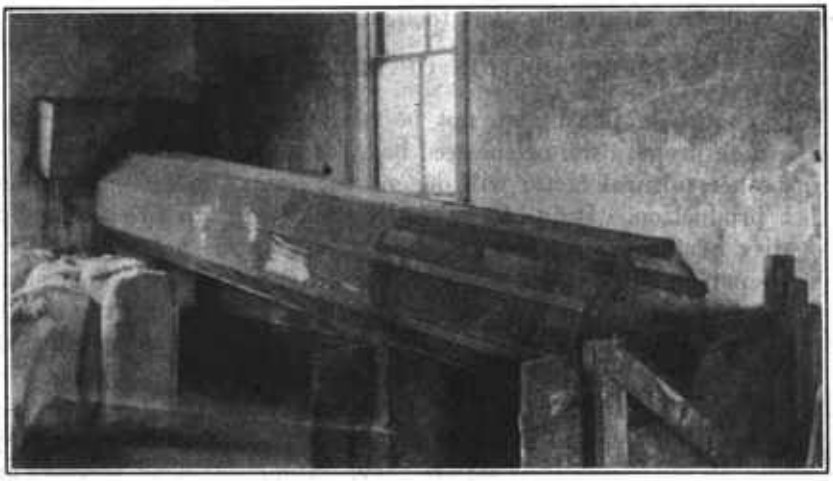

FIG. 3.—A homemade seed grader. The octagonal frame is covered with sieves of increasing coarseness, first permitting the dust and fine seeds to fall through; second, the small flax seeds of marketable grade; and, third, the plump, large seeds for sowing, while the twigs and coarse material pass out at the end.

The seed should be passed through a fanning mill or a seed grader of such a nature that all dirt, chaff, weed seeds, and light, immature seed will be eliminated. A homemade seed grader which has done satisfactory work is shown in figure 3. Only the heavy, well-matured seed should be selected for planting.

Fiber flax should be sown as early in the spring as is practicable after the danger of freezing weather is past. The experience of flax growers in eastern Michigan shows that the best quality of fiber is obtained from early-planted flax.

The seed should be sown broadcast. This can be accomplished with many of the modern seeders. Satisfactory work has also been done with a fiddle seeder. In case the grower has a grain drill but

no broadcasting seeder, he can sow the flax in a satisfactory manner by pulling the grain tubes from the drill shoes and tying each tube behind its shoe.

The experience of successful fiber-flax growers in this country has shown that seed should be sown at the rate of from 5 to 7 pecks per acre. Six pecks per acre on well-prepared soil has given the most uniform satisfaction. When smaller quantities of seed are planted, the tendency of the stalks is to branch and become coarse, with a poorer quality of fiber. When greater quantities of seed are planted the stalks usually are very fine and uniform, but in case of rain accompanied by heavy wind near harvest time there is danger that the plants will go down, and, once lodged, it is nearly impossible for such thickly planted flax to regain an upright position.

After sowing, the seed should be covered about half an inch deep. This can be done with a very light peg-tooth harrow with the teeth set well back.

WEEDS AND DISEASES.

The presence of weeds in a field of flax grown for fiber is very detrimental, since it is necessary to remove them before preparing the fiber. When only a few weeds are present they should be pulled before the flax is harvested, but when the weeds are numerous it is not practicable to pull them, as is done in Belgium and Holland, and the best method of avoiding trouble with them is to plant fiber flax only on clean soil. There will be fewer weeds when flax follows clover or other sod.

The weeds which are most likely to be troublesome are Canada thistle, lamb's-quarters, pigeon grass, wild buckwheat, smartweed, morning-glory, pigweed, flax dodder, and some forms belonging to the mustard family.

The diseases which thus far have been most destructive to flax are those which are capable of living in the soil. After being introduced into the soil they may remain there several years, and then when flax is planted they may severely injure, and in some cases destroy, the crop. Flax wilt is one of these diseases which often does much damage.

The results of experiments conducted by Prof. H. L. Bolley, of the North Dakota Agricultural Experiment Station, indicate that flax growers may avoid introducing these disease organisms into the soil (1) by using thoroughly cleaned and graded seed and (2) by not applying barnyard manure which contains flax straw or chaff to land intended for flax. Moreover, since the organisms may live in the soil for several years, it is advisable not to plant flax on the same field more frequently than once in seven or eight years.

HARVESTING.

In order to secure the best quality of fiber, flax should be harvested before the seed is fully mature. Under average conditions the harvesting time is about 80 days after planting, though this period may vary from 70 to 100 days, according to season. Extremely hot and dry weather will shorten the growing period, while cool damp weather tends to lengthen it. When the lower parts of the stalks are turning yellowish and the lower leaves are beginning to drop, the flax should be harvested.

The usual method of harvesting fiber flax in European countries is by hand pulling, and this method has also been used in certain sec-

FIG. 4.—Pulling fiber flax.

tions of the United States where laborers could be secured at reasonable rates. (See fig. 4.) Under present conditions it appears impracticable to pull the flax in this country until a satisfactory pulling machine is made. Much work has been done along this line, and it seems probable that such a machine will be perfected.

When flax is cut a varying quantity of fiber is left in the stubble, and when put in the shock the cut ends of the straw are in direct contact with the soil, and the fiber in the lower portion of the stalk may become badly discolored or otherwise injured. These disadvantages, however, are offset to a considerable extent by the diminished cost of harvesting. Moreover, when proper attention has been given to the preparation of the seed bed the surface of the

field will be smooth and even, so that the flax may be cut very close to the ground.

Self-rake reapers, mowing machines with tables back of the cutting bars, and grain binders have been used for cutting flax. When either of the first two machines is used, it is necessary to bind the bundles by hand; and in case the mowing machine with the table back of the cutting bar is used two men are required to operate it, one to drive the team and attend to the machine and one to rake the bundles off the table. It seems, then, that flax can be harvested with least expense by using a grain binder, though this method also has a serious disadvantage in the difficulty which is often experienced in securing straight, uniform bundles, since flax tangles badly when being elevated and bound.

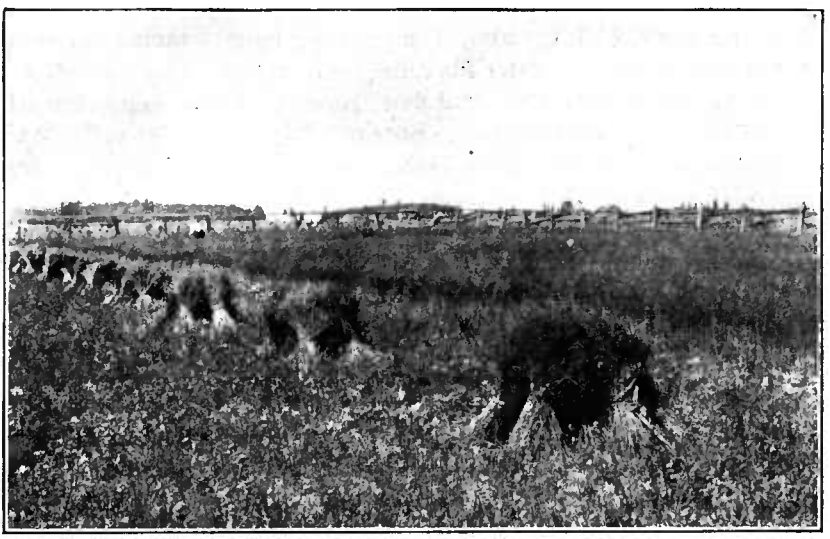

FIG. 5.—A field of fiber flax at harvest time. The bundles of pulled flax are set in small shocks to cure.

At the present time the grower receives $5 to $10 more per ton for pulled flax than for cut flax, and there is, of course, a larger quantity per acre when the crop is pulled. Since the cost of pulling ranges from $15 to $20 per acre, the advantage gained by pulling is questionable from the grower's viewpoint. Considerable progress has been made in developing flax-pulling machines. Several of these machines have been able to do good work on level fields of well-ripened flax. They have not as yet been demonstrated on a large scale as capable of handling fiber-flax fields "on the green side," or shortly before complete maturity, when it is best to harvest flax for fiber, but improvements are being made each year correcting the defects observed in the work of the machines in the field.

After the flax is harvested the bundles should be set up in small shocks to allow uniform drying. (See fig. 5.)

YIELD.

The yield of fiber flax is often expressed by giving the weight of harvested and cured straw before thrashing. This weight varies from 1 to 3½ tons per acre, though the average crop is from 1½ to 2½ tons. The quantity of seed which is borne on the straw varies from 4 to 15 bushels per acre, the average being from 6 to 10 bushels.

The yield of fiber will depend upon the care given to the preparation of the seed bed, the quality and quantity of seed sown per acre, the method of harvesting and of thrashing, and the manner of removing the fiber, as well as upon the available moisture and fertility of the soil. A yield of 770 pounds of clean retted fiber per acre has been obtained in eastern Michigan, though the average yield there is from 300 to 450 pounds per acre.

Breeding work, with the aim of developing long-stemmed varieties that will yield more and better fiber, has been carried on by the Bureau of Plant Industry since 1909, and more recently it has been taken up in Ireland, Holland, and Sweden. Strains of decided superiority have been developed, and efforts are being made to increase the seed for commercial sowing. A long-stemmed uniform variety gives an increased yield to the acre, permits cutting with a lower percentage of waste in the stubble, reduces the cost of handling for the unit of weight, stacks easier and better, rets more uniformly because of the uniform diameter of the stalks, and produces longer and more uniform fiber.

MARKET.

The market has been a very important factor in limiting the production of fiber flax in this country. Under present conditions it is advisable for the grower to sell the flax straw with the seed on it to a flax dealer. The farmer is thus relieved of the retting and breaking processes.

The practice in eastern Michigan is for fiber flax to be grown under contract. The farmer purchases the seed from the flax dealer and furnishes the land and labor required to produce the crop. After harvest he delivers the cured flax straw to the dealer at the mill for a price usually agreed upon at planting time. The flax dealer stores the straw in warehouses or in stacks (fig. 6) until he can thrash it and prepare the fiber. The prices paid to the farmer during the past three years have varied from $20 to $35 per ton, depending upon the condition of the straw and also upon whether the flax was cut or pulled.

PREPARATION OF THE FIBER.

The preparation of spinning fiber from flax straw is a process involving skilled labor and special machinery. These conditions

render it impracticable for the individual flax grower to undertake it, though it might be practicable for a number of growers to do so by cooperation. An association of growers could secure the services of an experienced man who would superintend the various processes.

THRASHING.

The first operation after the flax is harvested and cured is to remove the seed. A method should be employed whereby the seed bolls may be crushed or stripped off without breaking, doubling, or otherwise injuring the straw.

The common practice in this country has been to pass the head ends of the bundles between two wide pulleys held together by springs.

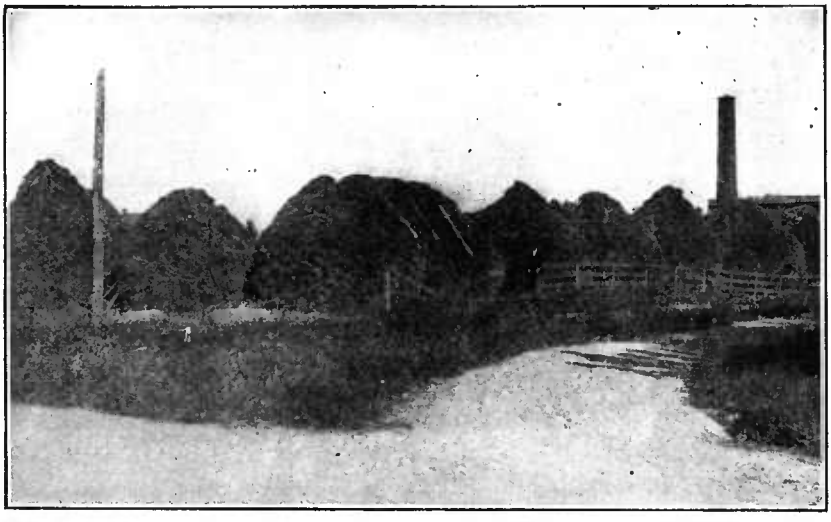

FIG. 6.—Stacks of pulled fiber flax grown in eastern Michigan in 1914. Sometimes flax stacks are thatched, in order to better protect them until the fiber can be prepared.

(See fig. 7.) The mixture of seed and chaff thus obtained is passed between two rollers located just above the hopper of a fanning mill. The rollers crush any seed bolls in the mixture, and the fanning mill separates the seed from the dirt and chaff.

Another machine for thrashing fiber flax has been put in operation by one of the flax companies in eastern Michigan. (See fig. 8.) The flax passes sidewise across the feeding table between the belt and the large wheel and is thus held firmly, while a toothed cylinder, revolving just back of the large wheel, beats against the heads and removes the seed. The seed passes through the machine and is cleaned by means of sieves and fans, as in a machine for thrashing grain. The straw passes along into a binder attachment and is again made into bundles. In this manner the straw is kept straight and in a form

convenient to handle. It has been stated that this machine will thrash about 15 tons of flax a day.

RETTING.

The retting of flax consists of a treatment which will loosen the fiber from the woody portion of the stalk so that it may be readily removed. There are three principal methods of retting, viz, dew retting, water retting, and chemical retting. The process is of such a nature that an inexperienced person should not attempt it unless there is some one to superintend the work who does understand it. This statement holds for all three retting methods, yet it applies especially to water retting and to chemical retting.

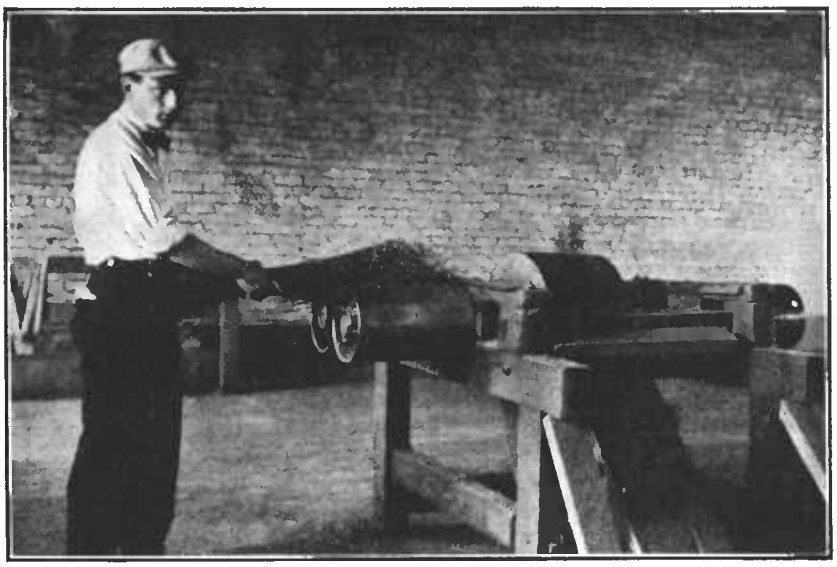

FIG. 7.—Machine for thrashing fiber flax. The seed end of the bundle is passed two or three times between the wide pulleys, which revolve toward each other and are pressed together by springs.

Dew retting is the method employed in many of the flax-growing provinces of Russia and has been used in this country to a greater extent than the other methods. It consists of spreading the thrashed straw in straight rows on a field, preferably a meadow, and allowing the action of rain, dew, or snow to remove the gummy materials which cause the fiber to adhere to the woody portion of the stalks. (See fig. 9.) This takes place in two to eight weeks, depending upon the climatic conditions. The straw is sometimes turned once during the retting process.

The best flax fiber is obtained from the Courtrai region of Belgium, where flax is water retted in the River Lys. Flax is also water retted in Ireland and in certain provinces in Russia, but in these countries

the retting is done in pools or reservoirs. The bundles of flax are usually placed upright in crates, or nets, and are immersed by placing weights on top of the whole. As fermentation progresses it is generally necessary to add more weights in order to keep the straw under water. The retting process is usually completed in from 6 to 15 days, depending upon the condition of the water. The straw should be removed at just the proper time, as a few hours' delay often causes loss. The practice in Belgium and in some portions of Ireland is to watch constantly during the latter part of the retting period, in order to remove the straw from the water at the time when the retting process has progressed sufficiently, even though this be during the night. The straw is set on end to drain for about 24 hours and is

FIG. 8.—A flax-thrashing machine. The lower ends of the stalks may be seen passing between the belt and the large wheel, which hold them while the seed bolls are stripped off by a cylinder. The straw passes into the binder at the left and is made into bundles.

then spread over a meadow for a few days, in order to become thoroughly dry. After drying, the straw is stored until time for breaking and scutching. Water retting in tanks is practiced in Oregon.

The chemical retting process has received considerable attention during the last few years. Various methods have been tried experimentally, but only a very few have been used on a scale sufficiently large to demonstrate whether they were practicable. A number of attempts have been made to ret chemically the thrashed straw of the seed flax grown in the Northwest and thus secure a fiber suitable for spinning, but none of these processes which have come under the observation of the Office of Fiber-Plant Investigations have been successful.

Promising results are being obtained, however, by one or two experimenters who have been using the tall, straight straw from fiber flax. Two points in favor of a chemical retting process are that it is a rapid one and can be used the year round regardless of weather conditions. Spinners say that the fiber obtained in this manner is not suitable for general use, yet apparently it can be used successfully in certain lines of manufacture.

BREAKING, SCUTCHING, AND HACKLING.

One type of machine which is in general use for breaking flax straw is shown in figure 10. Very often the rollers of each succeeding pair have smaller corrugations and fit closer together than those of

FIG. 9.—Flax straw spread for dew retting. Most of the fiber flax grown in the United States has been dew retted.

the one just preceding. The dry retted straw is fed endwise between the fluted rollers, and the woody portions of the stalks are broken into small pieces, while the fiber, being tough and elastic, remains unbroken.

The breaking process reduces the woody portion to short, small pieces, called shives, but removes only a small percentage of it. The shives are removed by scutching. The common method of doing this is by subjecting the broken straw, a handful at a time, to the beating action of a wheel with paddles radiating from its center. Combined breaking and scutching machines are coming into use, thus reducing the hand labor.

After the fiber has been scutched it is reduced to a finely divided condition by a process known as hackling. This is done in some

cases by machinery, though the best work is done by hand. The principle involved in either case is similar and consists of drawing the fiber over two or more series of sharp steel pins, the pins of each succeeding series being smaller and having sharper points. The fiber is thus divided to the degree of fineness desired by the spinner. Hand hackling at the scutching mills is being replaced by machine hackling at the spinning mills.

POSSIBILITY OF ESTABLISHING A FLAX-FIBER INDUSTRY IN THE UNITED STATES.

It has been demonstrated beyond all doubt that fiber flax of excellent quality can be grown in various sections of the United

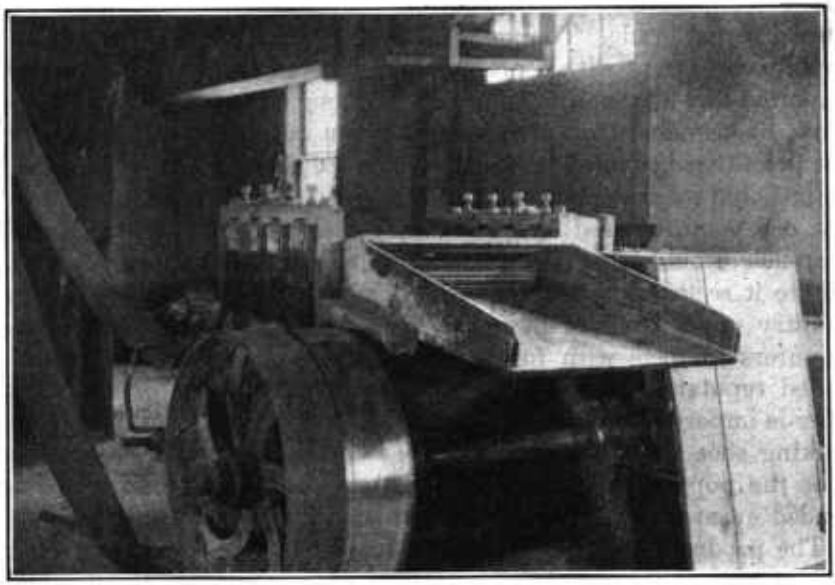

FIG. 10.—A flax brake. The woody portion of the retted flax straw is broken by passing the straw between the fluted iron rollers.

States, yet it can not be said that the industry has ever become established here. One reason for this is that much cooperation is necessary between the different branches of the industry, and up to the present time this cooperation has not existed. The farmer can grow the flax, but before doing so he should be assured of a market. On the other hand, the manufacturers should be assured of a sufficient supply of flax in order that they may establish their branch of the industry.

The individual farmer can grow fiber flax, but it is not practicable for him to carry on the processes of preparing the fiber. If the farmers wish to do this, they should agree upon some form of organization whereby they would be enabled to hire an experienced man

to superintend the work of preparing the fiber. Unless there are a number of farmers willing to cooperate in some such manner, it is advisable that they grow flax under contract with a flax-fiber dealer. The dealer undoubtedly would be glad to offer suggestions regarding the various phases of flax culture and after harvest would purchase the flax straw from the farmer. The flax dealer would then prepare the fiber for the manufacturers, as he would be in touch with market conditions.

The price which the flax dealer can pay to the farmer is governed by the price which he in turn can secure from the spinner. The difficulty in the past has been that the spinners and manufacturers in this country have been willing to pay but little more than half as much for American-grown fiber as they have paid for imported fiber of equal grade. The manufacturers in turn may be contending to a certain extent with a prejudice which seems to exist in favor of imported flax fiber and linen goods. As long as such a situation prevails, linens made from American flax can not sell in our stores for the price that is quoted on foreign linens of equal grade. If a salesman should offer at the same price two pieces of linen of equal quality, one manufactured in this country and the other imported, the customer would almost invariably purchase the imported goods. Hence it seems apparent that only when the users of linen in this country are willing to buy American-made goods can our manufacturers compete with foreign houses whose goods have an established reputation. Since, however, about $3,000,000 worth of flax fiber is imported annually by our manufacturers for the purpose of making shoe thread, sewing thread, twines, and toweling, it seems that the popular prejudice against American linens has been extended even against American-grown fiber.

The production of flax fiber in Europe has been decreasing, and just at present the supply of European fiber is much reduced. The present prices of this fiber are higher than in pre-war times. Even under very favorable conditions it will be several years before flax production in Europe will have regained its former proportions, and thus it seems that the present is a most opportune time for establishing a flax-fiber industry in the United States.

It must be remembered, however, that it is not advisable for the individual farmer to grow fiber flax commercially until he is willing to cooperate with either his neighboring farmers or a flax dealer. Only when there is hearty cooperation between the various branches of the industry from the grower to the manufacturer can there be hope of lasting success, but if this kind of cooperation should come into existence the popular prejudice against American linen goods could be overcome and a permanent flax-fiber industry of large proportions could be established.

SUMMARY.

The cultivation of flax for fiber and the cultivation of flax for seed or oil are two distinct industries. Fiber flax is a variety distinct from seed flax.

Fiber flax yields both spinning fiber and seed suitable for oil production.

The straw of seed flax grown in the Northwest does not yield a fiber suitable for spinning.

Before the World War Russia produced about four-fifths of the world's supply of flax fiber.

About one-third of the flax spindles in the world are in Ireland.

The United States imports annually about $3,000,000 worth of flax fiber and more than $20,000,000 worth of linen goods.

The climatic and soil conditions in various sections of the United States are favorable for growing fiber flax. A relatively low temperature and sufficient moisture during the growing season are desirable. In general, a loam soil with a clay subsoil is to be recommended.

The preparation of the seed bed is one of the most important factors in the culture of fiber flax. Sod should be fall plowed. The seed bed should be rendered fine and compact before seeding.

The seed should be thoroughly cleaned and graded. It should be sown broadcast at the rate of about 6 pecks per acre and should be covered not more than half an inch deep.

Fiber flax should not be sown on soil infested with weeds, since the weeds would have to be removed at some time before the fiber could be spun.

Flax diseases live in the soil a number of years; consequently, it is not advisable that flax be planted on the same field more frequently than once in seven or eight years.

Pulled flax is of greater value for fiber than cut flax. The practice of pulling is recommended if practicable means of doing it can be perfected.

An average yield of fiber flax in this country is about 2 tons of unthrashed straw per acre, from which 6 to 10 bushels of seed and 300 to 450 pounds of clean retted fiber may be obtained.

The preparation of flax fiber requires technical knowledge, and should be undertaken only by those who are experienced in that line of work.

In the past the market has been an important factor in discouraging the production of fiber flax in the United States. It has been repeatedly demonstrated, however, that excellent flax fiber can be produced here, and it is hoped that the prejudice which has existed against American fiber and linen goods can be overcome by earnest cooperation among all those engaged in the industry.

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1922